EVALUATION RESULTS

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Agenda

Time	Topic	Who
13.00	Opening	Anna Schirokoff (Finnish Transport & Communications Agency)
13.04	Overview of evaluation activities in NordicWay 3	Satu Innamaa (VTT)
13.09	Emergency Vehicle Approaching - How driving simulators can facilitate evaluation	Kajsa Weibull (VTI) & Peter Smeds (Swedish Transport Administration)
13.27	Evaluation of societal benefits of C-ITS in traffic signals in Uppsala	Martijn Legêne (RISE/Gouappel) & Sampo Hinnemo (City of Uppsala)
13.45	Evaluation of geofence implementations	Ørjan Tveit (Norwegian Public Roads Administration)
14.03	Acceptance and need of real-time traffic information services in the transport industry	Esko Lehtonen (VTT)
14.21	Evidence on impacts of road transport automation from a Nordic perspective	Elina Aittoniemi (VTT)
14.40	Closing remarks	Anna Schirokoff (Finnish Transport & Communications Agency)

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Evaluation activities

- Builds on findings of NordicWay and NordicWay 2
- Focus of evaluation on
  - Ecosystems
  - User acceptance, HMI
  - Socio-economic impacts
  - Feasibility of C-ITS service provision in the Nordic countries
- Single evaluations were carried out by different deployment pilots across NordicWay 3
- Some joint evaluation topics
  - Roles & responsibilities
  - Costs

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Evaluation results deliverable

- Summarising all evaluation activities carried out under NordicWay 3, with references to original evaluation reports
  - Methods
  - Key results
- Findings on joint evaluation topics
- Discussion and conclusions across all evaluations

To be published in the spring 2024

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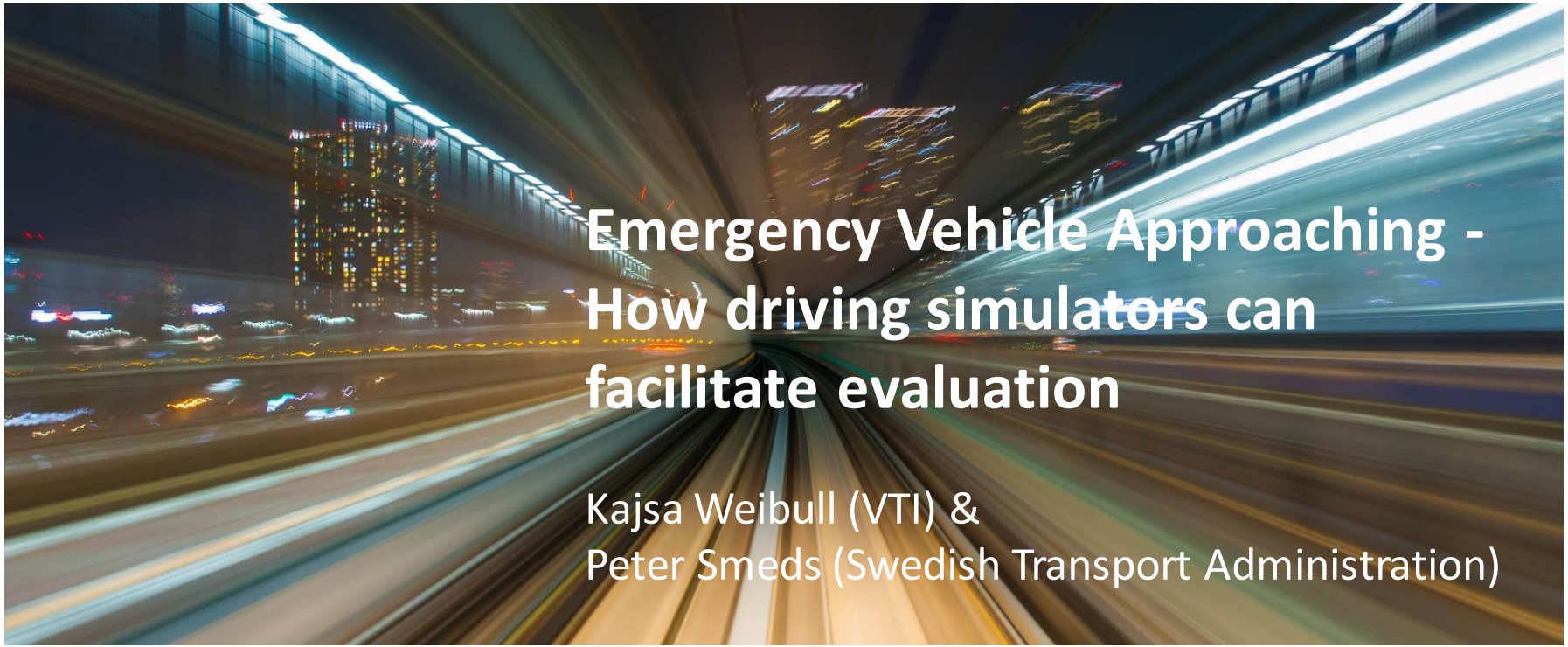
EVALUATION RESULTS



Emergency Vehicle Approaching - How driving simulators can facilitate evaluation

Kajsa Weibull (VTI) &
Peter Smeds (Swedish Transport Administration)

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EMERGENCY VEHICLE APPROACHING
– How driving simulators can facilitate evaluation

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Photo: Gamma-man/mostphotos.com

- Will the solution work?
- What benefit will it bring?
- What will it cost?

Background

Emergency driving is difficult

- for emergency vehicle operators
- for surrounding road users

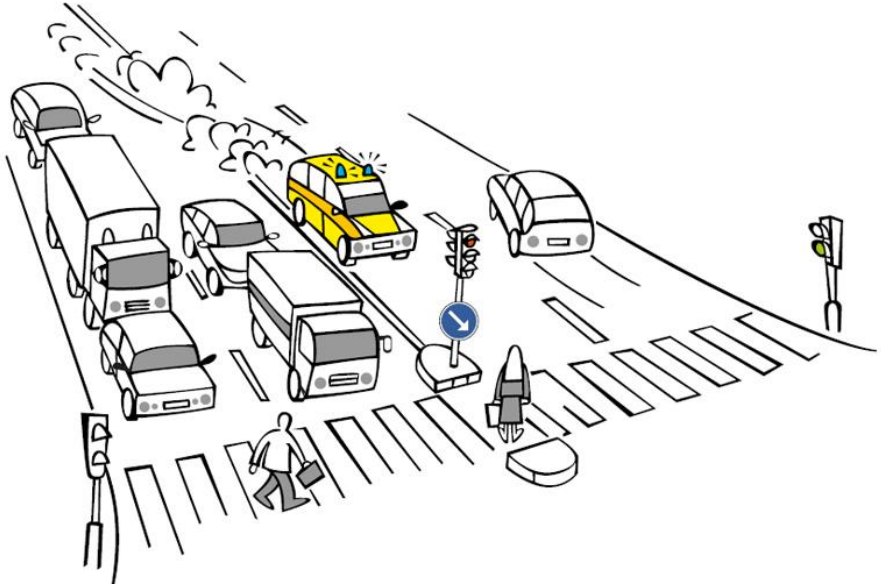

Image: https://ntf.se/konsumentupplysning/lagar-och-regler/trafikanter/fri-vag/

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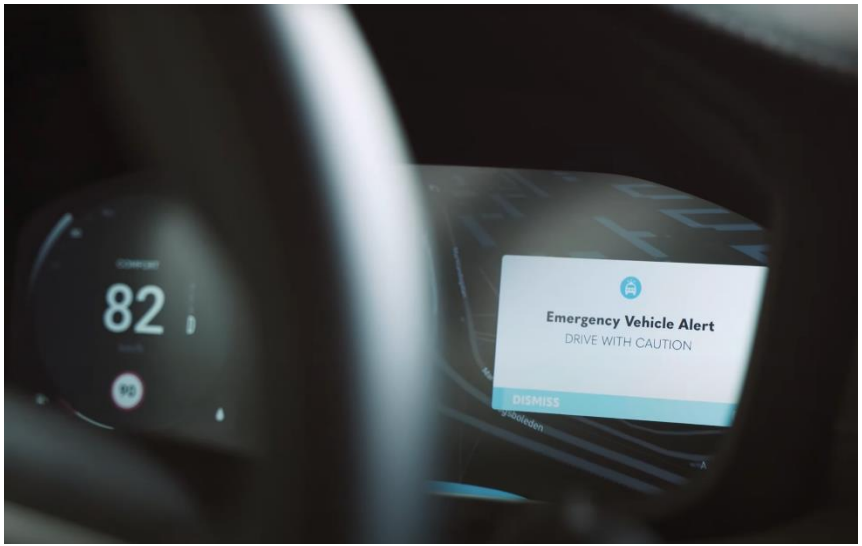
What is an EVA warning?



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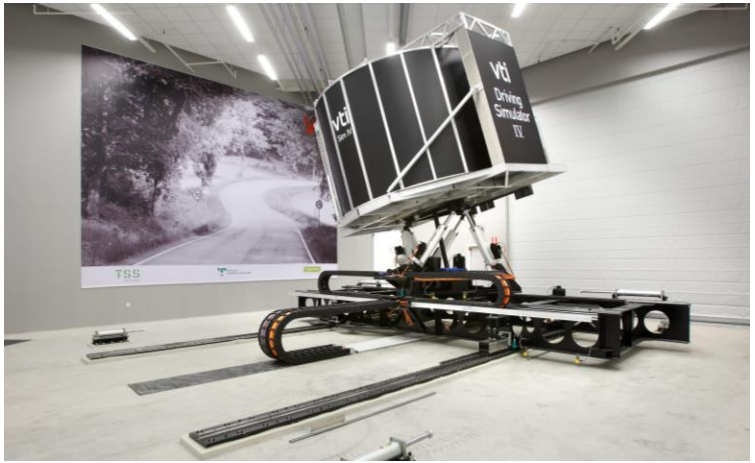

Why use driving simulators?

- Safe environment
- The participants will experience the same environment and events
- Easy to measure driver behavior in detail
- Practical when implementing a new system or service

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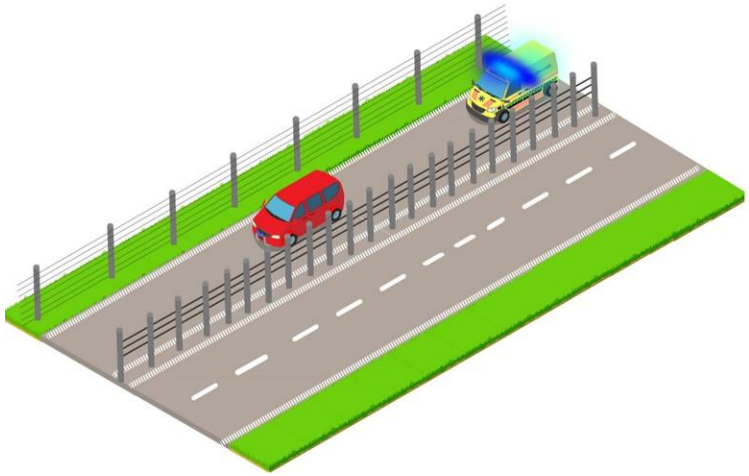
Photo: Tereza Kunclova
Hejdlösa bilder

Time saved with EVA?

Possible time save was examined in two simulator studies:

1: Countryside → Ca. 30 *s* per car

2: Highway → Ca. 0.5 *s* per car



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Time saved with EVA?

- Average response time 15 min
- In Sweden 6 000 out of hospital cardiac arrests/year
- One min shorter response time = Increase chance to survive with 0.7 % units
- One min shorter response time = 42 lives saved/year
- An economic value of a life is 3.5 million Euro
- Saving one life per year is enough to bring societal and economical benefit

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HLR-rådet (2022). Årsrapport. SHLR Årsrapport 2021 (registercentrum.se)
Sund, B. (2010). Effect of response times on survival from out-of-hospital cardiac arrest: using geographic information systems. Working paper, Örebro University.

Preventing accidents with EVA

- Intersection study
- Common situation for accidents
- Half of the participants who did not receive an EVA warning drove through the intersection without stopping or the emergency vehicle

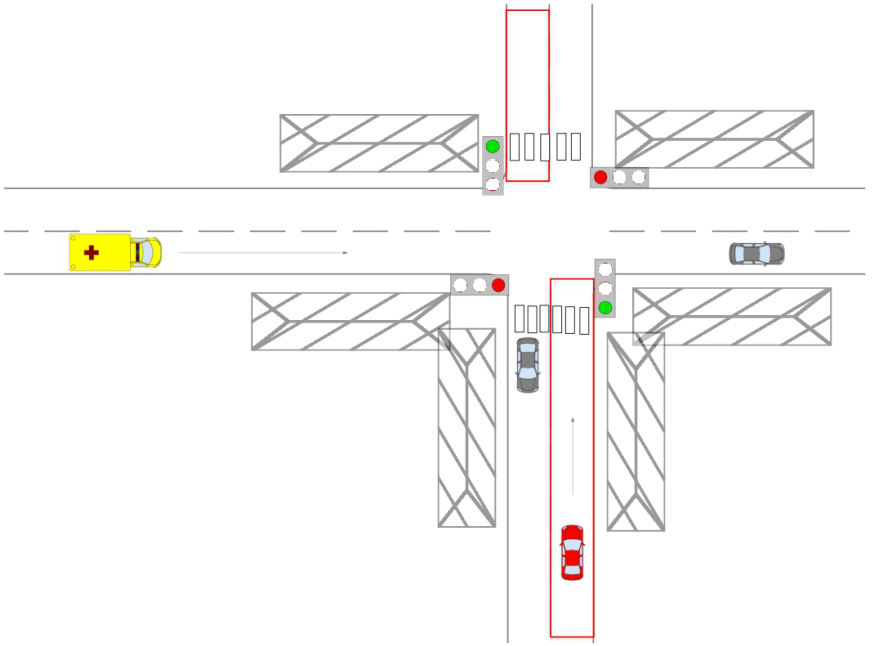

Figure by: Tereza Kunclova

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Photo by: Kajsa Weibull

Conclusions

- Simulator studies can give us an indication of how ITS services would work in real traffic
- There are life saving benefits with EVA
- Both for time and accident prevention
- There are still challenges

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Thank you for your attention!

kajsa.weibull@vti.se

peter.smeds@trafikverket.se

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Evaluation of societal benefits of C-ITS in traffic signals in Uppsala

Sampo Hinnemo, Municipality of Uppsala
Martijn Legêne, Goudappel

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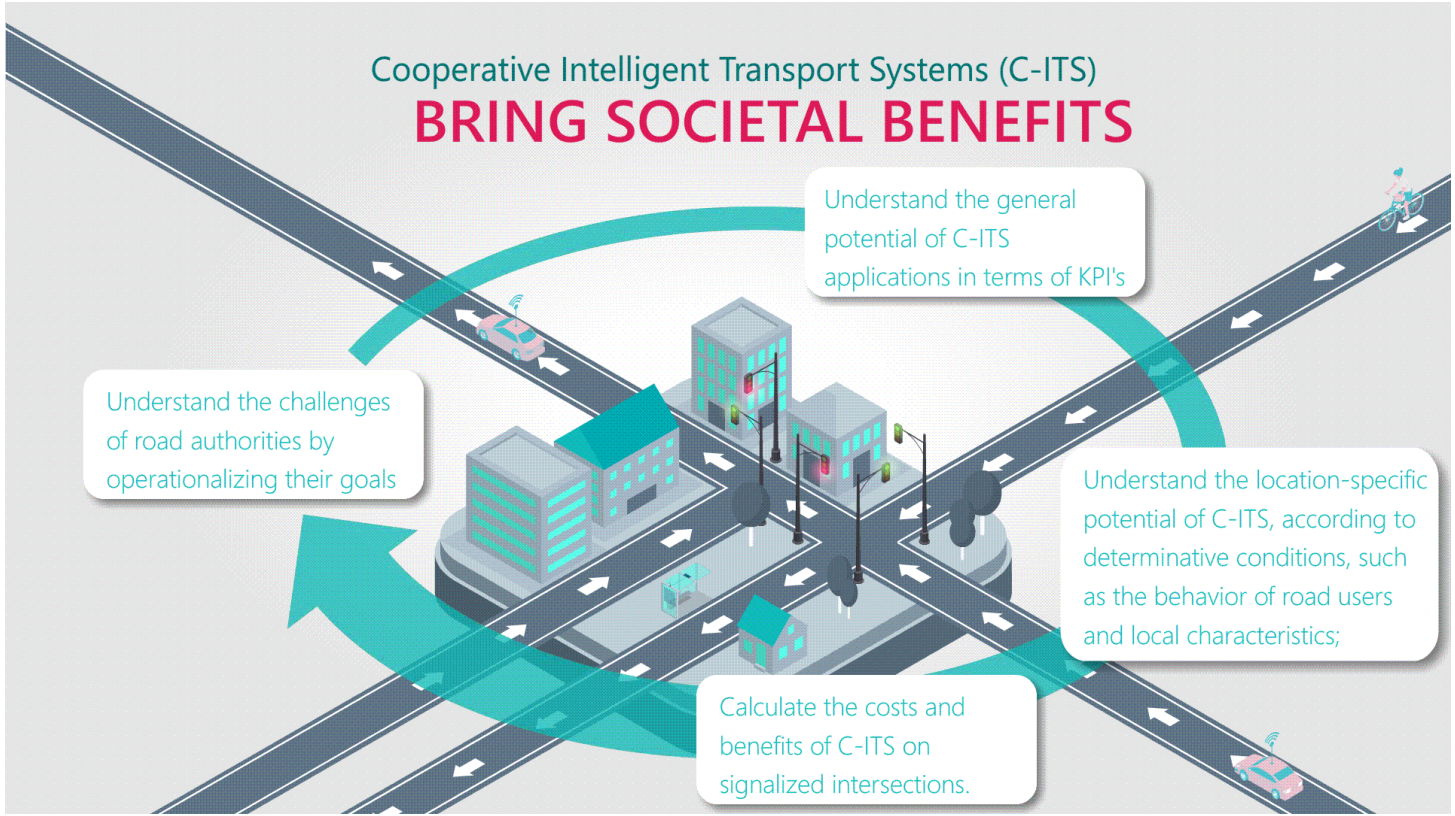

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Sampo and Martijn

- Sampo Hinnemo (Municipality of Uppsala)
- sampo.hinnemo@uppsala.se

- Martijn Legêne (Goudappel)
- mlegene@goudappel.nl

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Transport goals in Uppsala

- Space must be used in a more efficient way
  - Prioritize pedestrians, bikes and PT in central Uppsala
- Prioritize heavy vehicles on pointed out thoroughfares
  - In non-residential areas, so noise pollution won't impact
- Decreased level of pollution (NOx, particles, CO2, noise)
- Reduced wear and tear on road surfaces
  - Less frequent breaking and accelerating (especially heavy vehicles)

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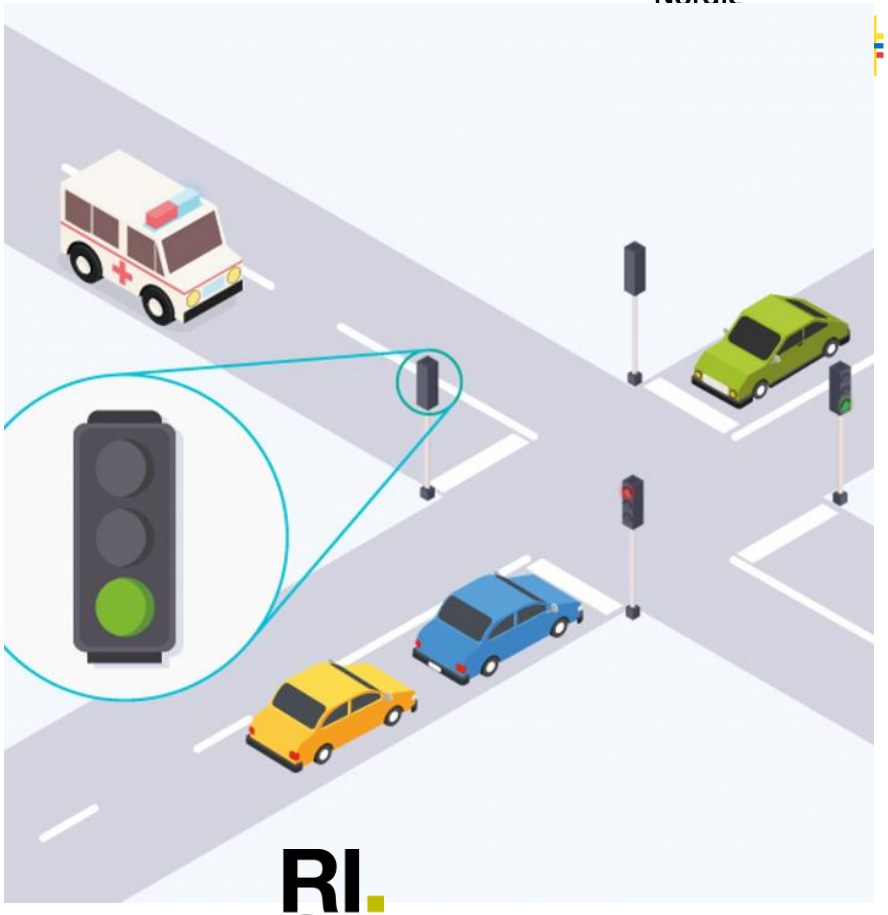
Use cases

- Potential (C-)ITS-systems:
  - Informing: Time to Green (TTG), Time to Red (TTR), GLOSA
  - Prioritizing
- **Selection of use cases**:
  - Solitary intersection with TTG/TTR and/or GLOSA
  - Green wave corridor with GLOSA
  - City Center corridor with bus priority



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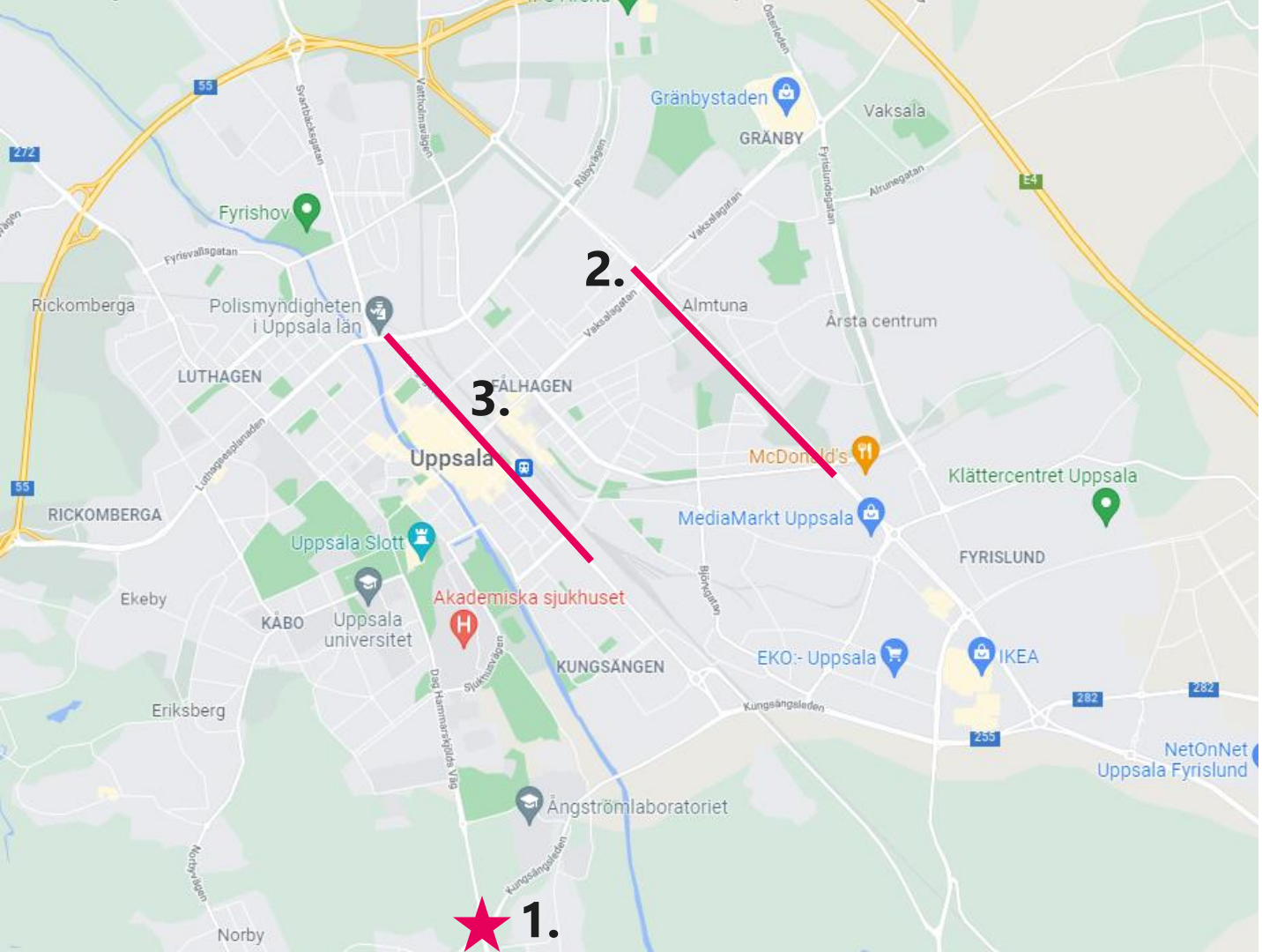


Nordic WAY

Selection of use cases and location

1. Intersection between the Kungsängsleden and Dag Hammarskjölds Väg in the south of Uppsala
   - TTG/TTR
   - GLOSA
2. Corridor with coordinated intersections, on Uppsala's Tycho Hedéns Väg
   - GLOSA
3. City center corridor with bus priority at Kungsgatan
   - Priority

a

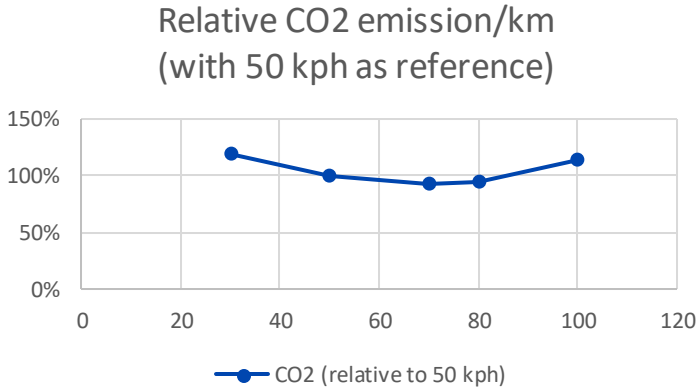
RI. SE

Uppsala kommun

Goudappel MOBILITY MOVES US

Results: Realistic expectations

- Limited impact, possible improvements on environmental KPI's
  - Compared to well functioning current situation (vehicle actuated)
  - Promising for hybrid cars
- The impact is strengthened on corridors
  → scaling up
- Stops is <u>not</u> the most important KPI



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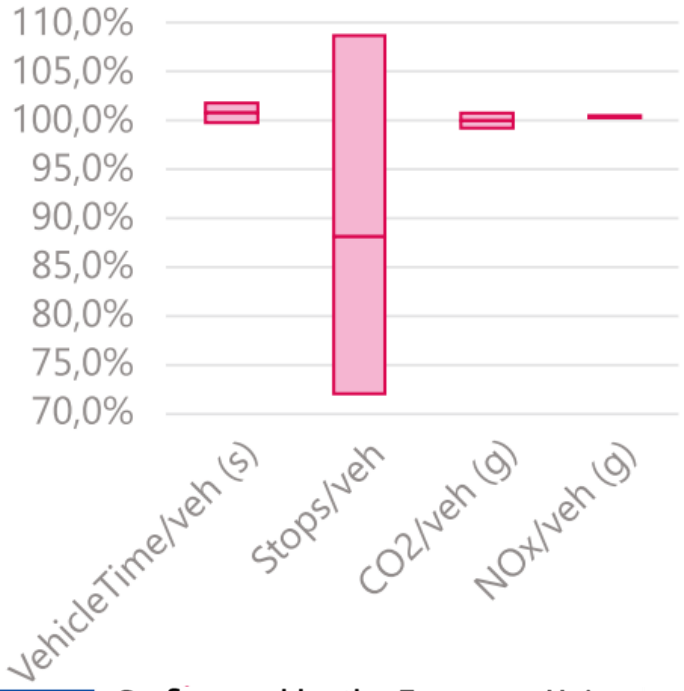
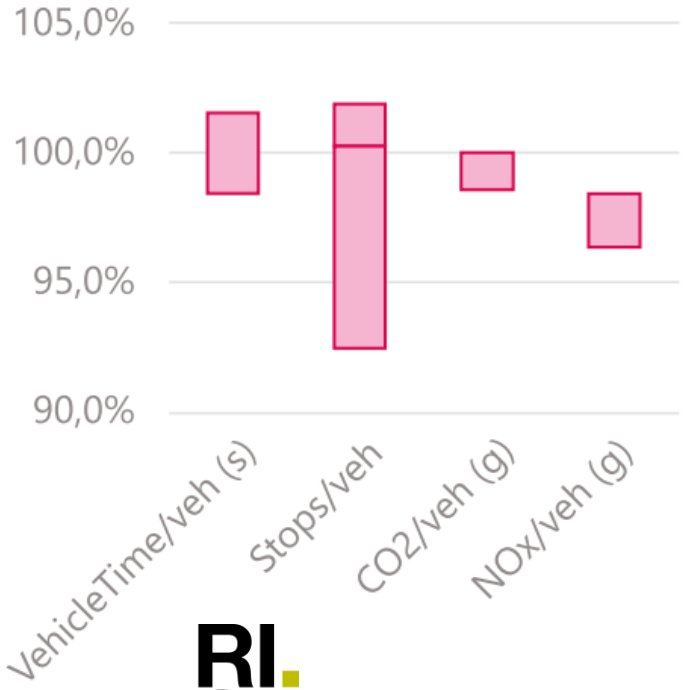
Usecase 1: Solitary intersection

Impact TTG/TTR (compared to no information)



Impact GLOSA (compared to no information)



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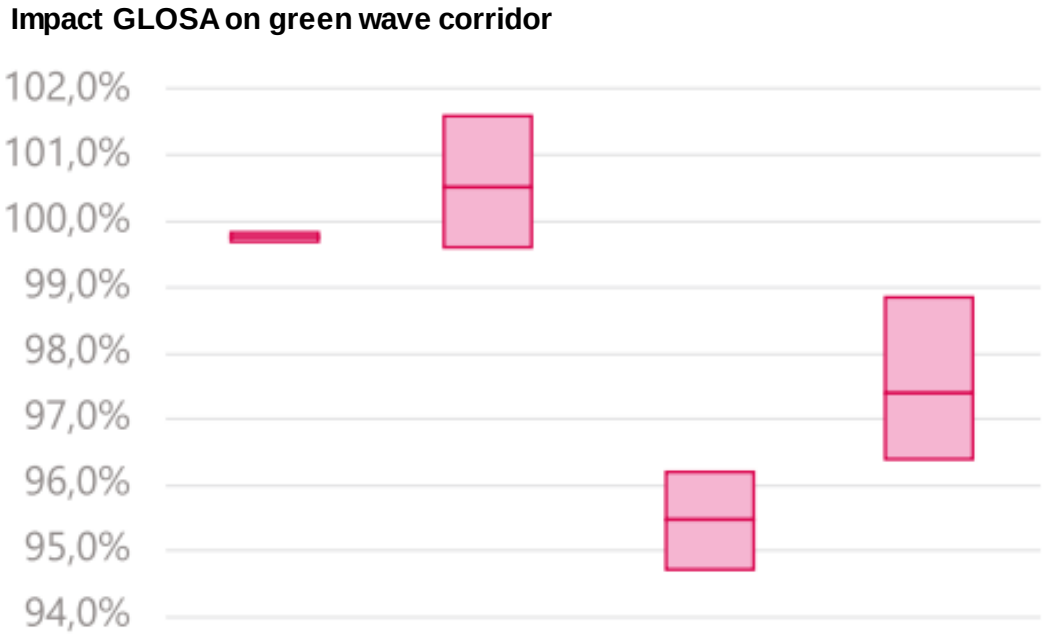
Usecase 2: Corridor with GLOSA



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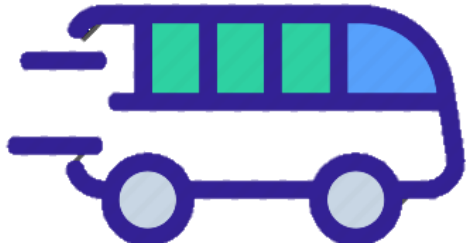
Usecase 3: City center corridor with bus priority

- Bus priority improves traffic flow of public transport
  - Up to 50% less travel time loss per intersection (-10% vehicle hours)
  - Corresponding with 1-2 minutes travel time savings per busline
- With minimal negative impact for other road users
  - No extra travel time loss for slow modes
  - 6% extra travel time loss for cars
- Conclusion:
  - Bigger impact when using C-ITS to prioritize and optimize traffic
  - Compared to informing (GLOSA)



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Soft benefits of C-ITS

- User experience
  - Improved driving experience and more comfort
  - Car can become more popular → is that what we want?
- Safety
  - Access to more information, better anticipation, improved reaction times and reduced likelihood of accidents
  - More harmonized traffic, less speed differences, less taking over
- Environment
  - Fewer stops leads to less acceleration/deceleration and less noise

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Factors that influence the succes of C-ITS

- % of vehicles with C-ITS connection (penetration rate)
- Traffic load (morning, rest day, night)
- Type of traffic signaling (fixed versus vehicle actuated)
- On corridor: distance of advice
- Directions of road (main direction or all)

No significant impact

- Buffer time (time to arrive at intersection)
- Solitary intersection: distance from intersection where advice is given (100m, 500m)
- Cars included in GLOSA
- Continuity of advice

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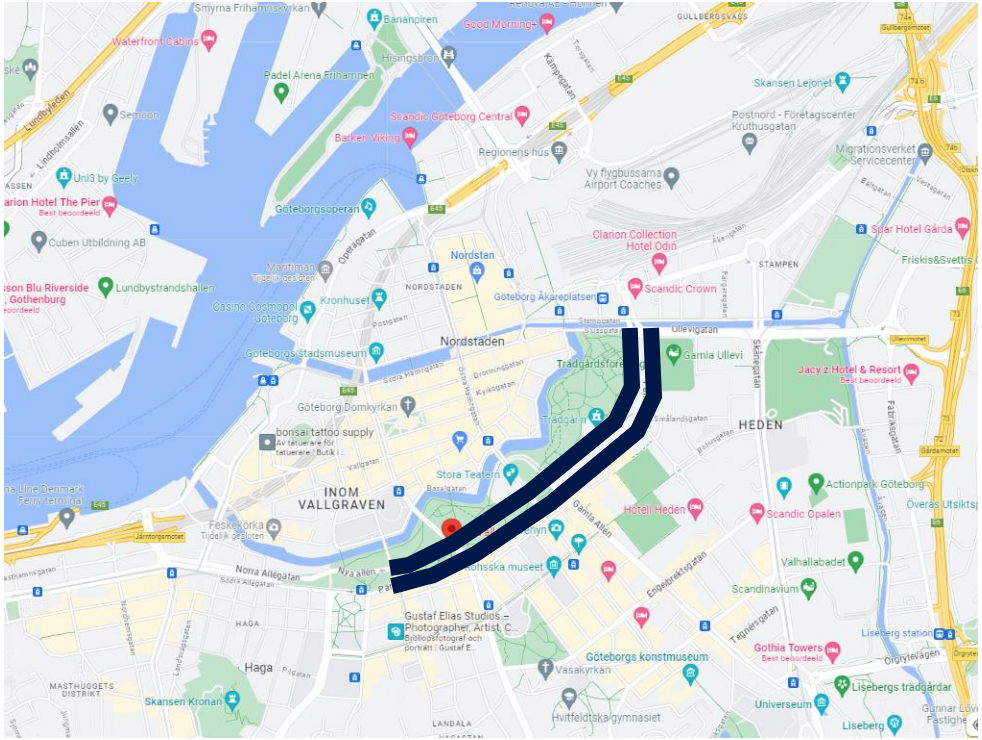
Results GLOSA in Gothenburg (Nya Allén)

Every % of impact is important in challenge to emission free transport

- Similar results as Uppsala
- GLOSA as a driver to set up multiple C-ITS
- See us at the POLIS conference



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Guideline on NW3 Sharepoint

https://assets-global.website-files.com/5c487d8f7febe4125879c2d8/656327981f695122e018f7ed_NordicWay%203%20Guideline%20to%20assess%20societal%20impact%20of%20C-ITS%20on%20signalized%20intersections.pdf

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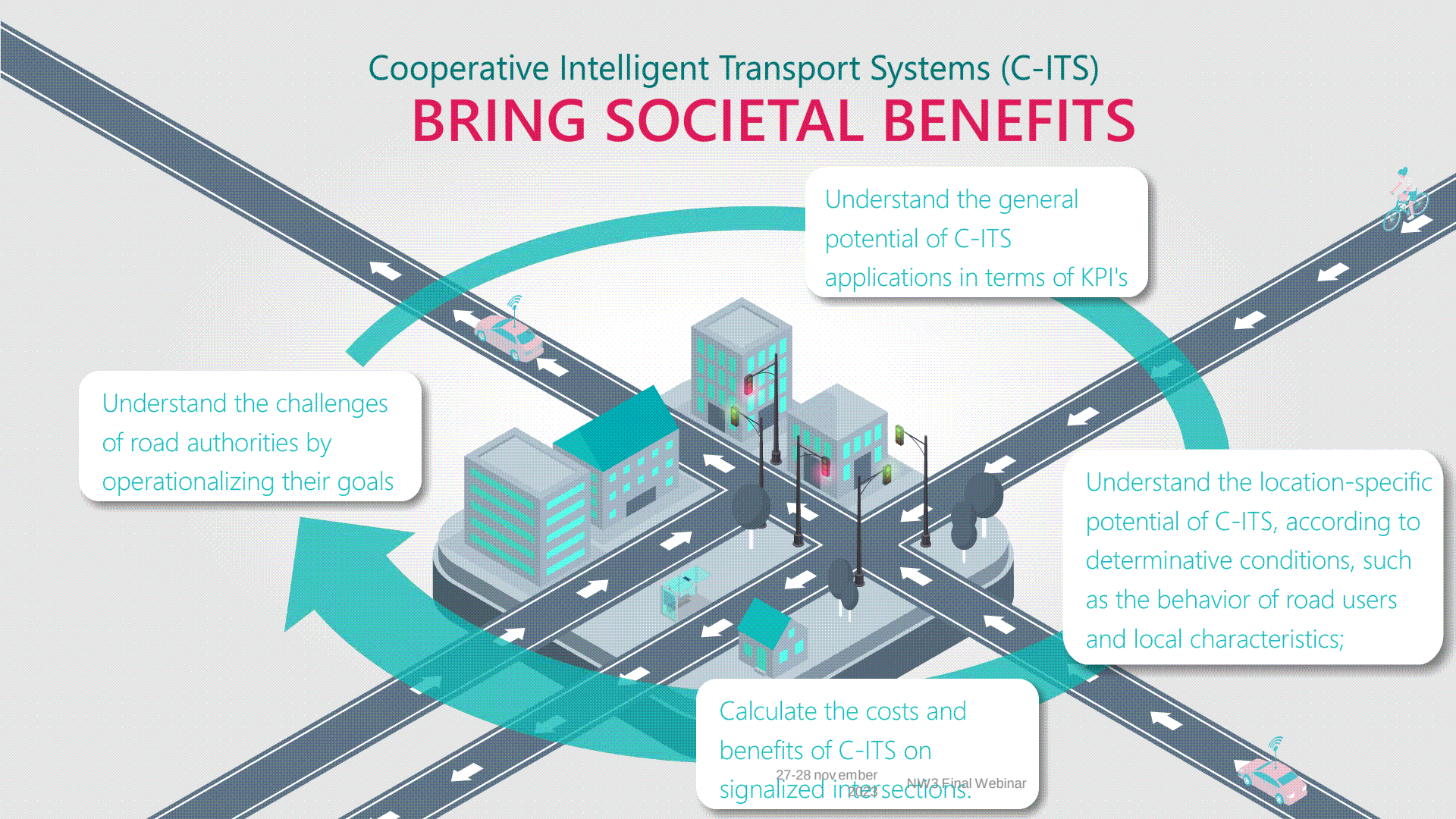
Cooperative Intelligent Transport Systems (C-ITS)

BRING SOCIETAL BENEFITS



Understand the general potential of C-ITS applications in terms of KPI's

Understand the challenges of road authorities by operationalizing their goals

Understand the location-specific potential of C-ITS, according to determinative conditions, such as the behavior of road users and local characteristics;

Calculate the costs and benefits of C-ITS on signalized intersections.

EVALUATION RESULTS

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Nordic WAY

What is a geofence?

A geofence is a virtual and geographically placed zone.

For traffic management it is possible to add rules, requests or information to these zones, communicate them to the vehicles, and control the vehicles or inform the drivers.

The vehicles can also share data back

The only limit is your imagination!
Ban all red cars from the city ?

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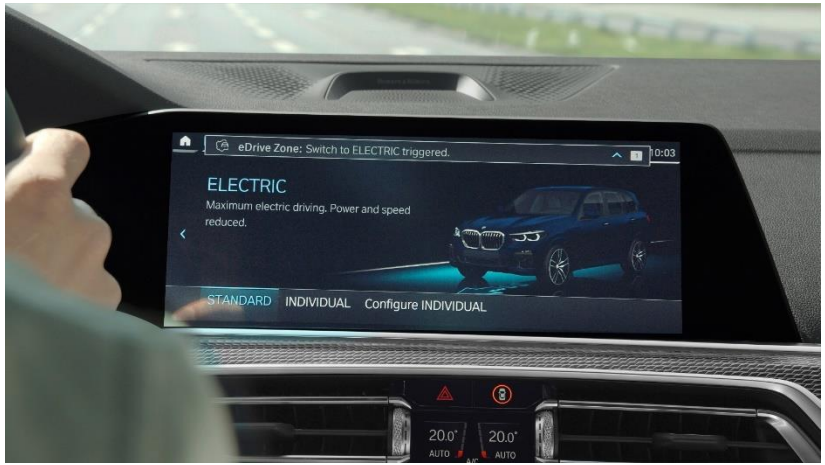
Survey – management of hybrid BMW

BMW allowed local government to define low emission zones and automatically shift the cars towards electric drive when hybrid BMW entered the zone.

NPRA defined low emission zones in four Norwegian cities and asked the drivers about their experience.



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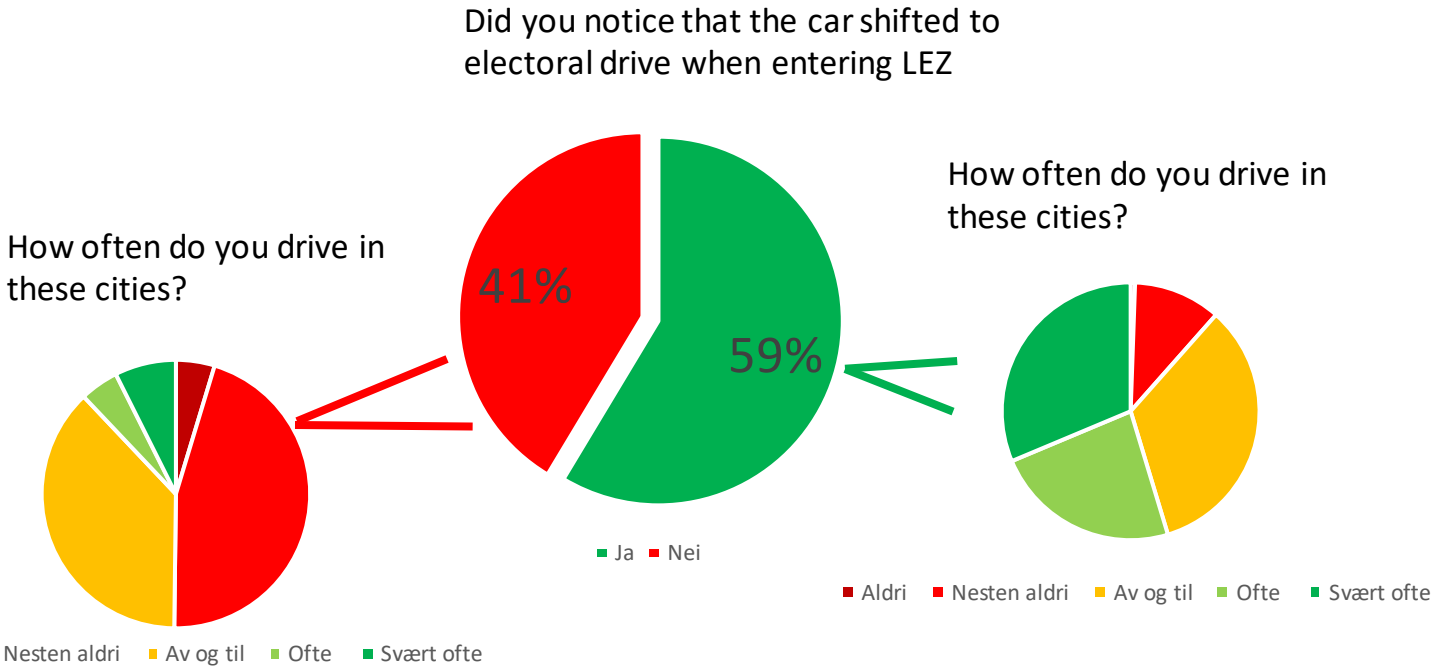
Survey – management of hybrid BMW



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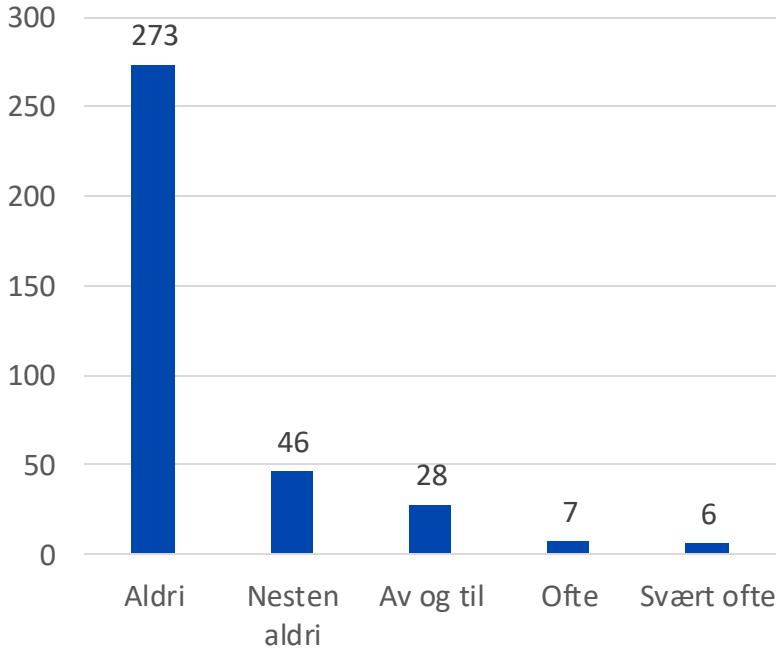
Survey – management of hybrid BMW

- Drivers mainly accept the eco-friendly function.
- Only 4 % are annoyed and shifts back to dual mode.

- This demonstrates that it is possible for authorities to make use of the technology in advanced vehicles at lower SAE-levels by defining the use of these to be voluntary and by allowing the drivers to switch off the functionality.



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Survey – management of hybrid BMW

To what extent do you think/do you think that the automatic low-emission zone functionality has helped **you** to drive more environmentally friendly?

To what extent do you think/do you think that the automatic low-emission zone functionality has helped **everybody** to drive more environmentally friendly?

Noticed new setup (n=351)

Not noticed new setup (n=242)

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Survey – road user charging

By exploring the technology in a voluntary use case, it is possible to gather experiences from the drivers based on their use of the system in their everyday life, enabling a largescale data collection.

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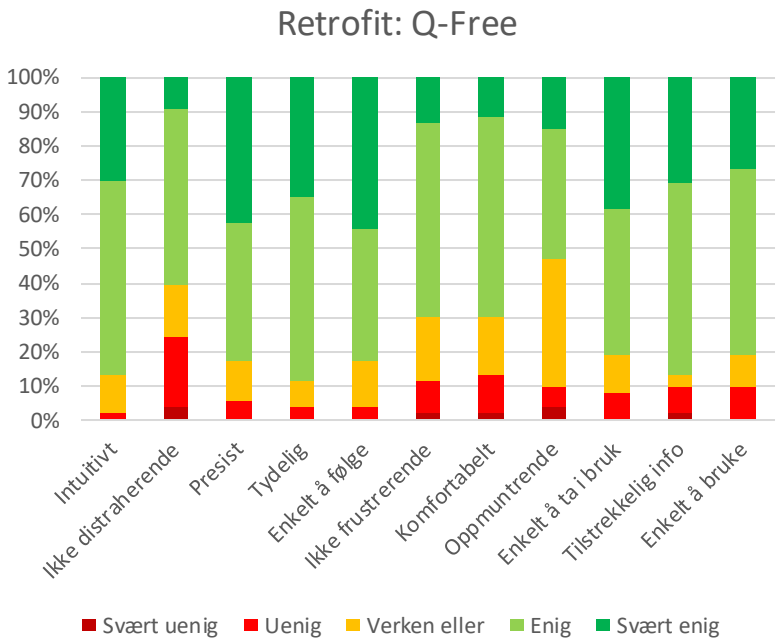
Survey – road user charging

GeoSUM project

Based on a cellular phone we aimed at changing the use of drive line from towards electrify in the city centre.

Aimed at no cost for driving electrical and a cost per km for driving by fossil energy.



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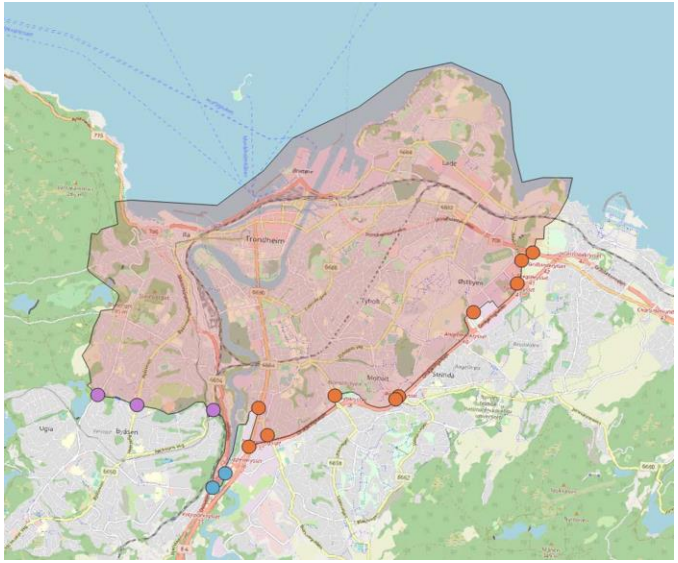
Survey 2 – road user charging

Replace toll stations with distance-based road pricing

Geoflow project:

- Defined a price-zone in the city center of Trondheim
- Higher prices during rush hours
- 126 participants



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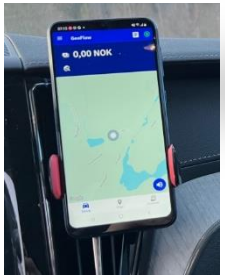
Survey 2 – road user charging

Pre-survey

- Sent immediately after equipment installation
- Exploring daily habits and expectations and attitudes toward technology, data storage, road pricing and toll stations.

Post-survey

- 2-3 months after installation
- Exploring experiences and attitudes toward the tested technology



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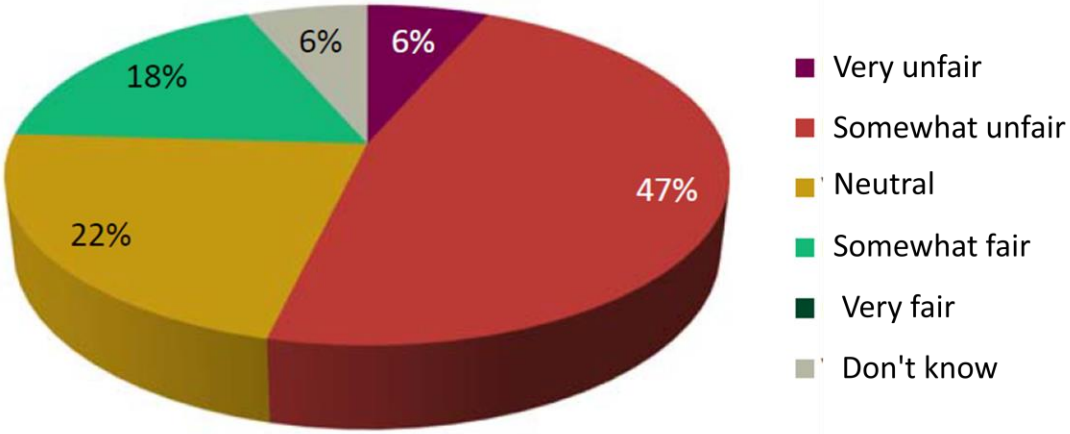
Attitudes toward the current toll system

- **Pre-survey findings**
  - How fair do you consider the current toll system in Trondheim?



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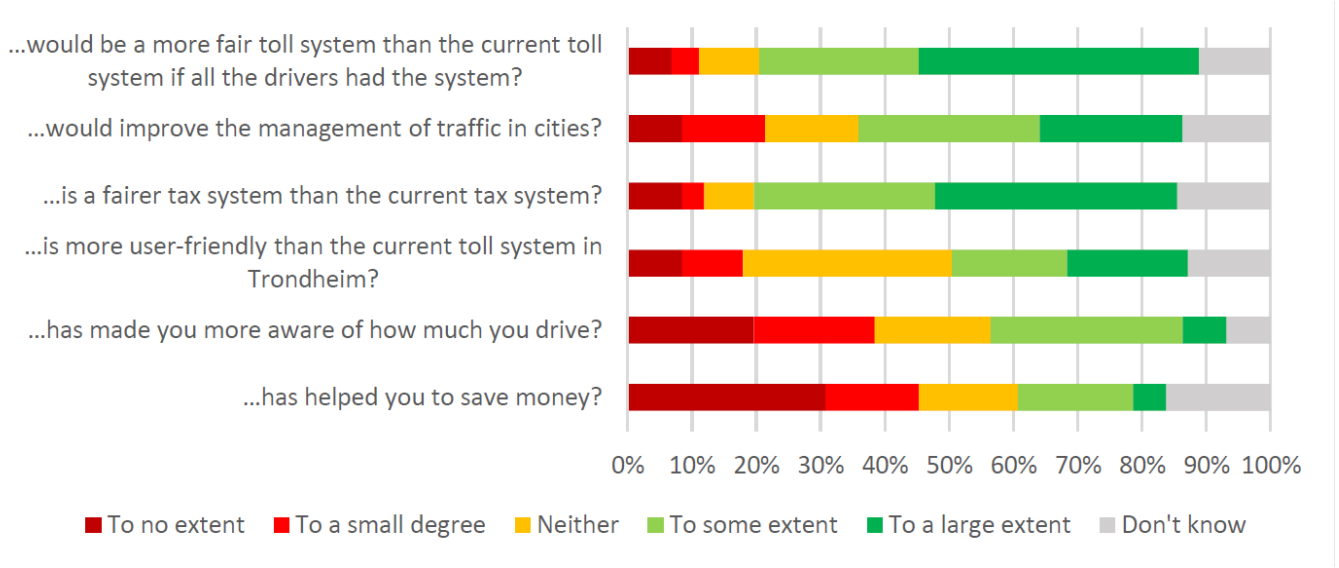
Usefulness of road user charging

- **To what extent can you say that road pricing …**



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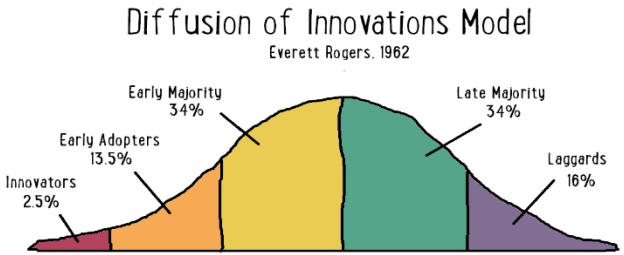
Takeaway

Trials or piloting studies are often conducted under limited circumstances – such as time or location.

By introducing new functionality as a voluntary test, more drivers will experience learning, and this will over time influence how they experience being regulated automatically by digital traffic laws.

Voluntary use cases are examples of how authorities could move forward in terms of using adaptive policymaking, since voluntary policies are more flexible and easier to adjust over time as experience and knowledge about the use case is brought forward.



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EVALUATION RESULTS

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Aim of the study

- C-ITS studies have previously focused on car drivers
- Aim was to understand the views and needs of professional drivers, transport coordinators, and C-ITS service providers in the field of freight transport

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Research topics

- Acceptability of Day 1 & Day 1.5 C-ITS services
- Willingness to participate in C-ITS service production and service use
- Capability to utilise information from C-ITS services in logistics
- C-ITS service development ideas
- Factors encouraging the introduction and continued use of C-ITS services
- Especially demands for spatially and temporally bound information

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Methods

- Internet survey to professional drivers (79 respondents, 14.10. – 22.11.2020)
- Phone interviews with transport coordinators (8 interviews)
- Phone interviews with the C-ITS service providers (3 interviews)
- Literature review
- Impact assessment

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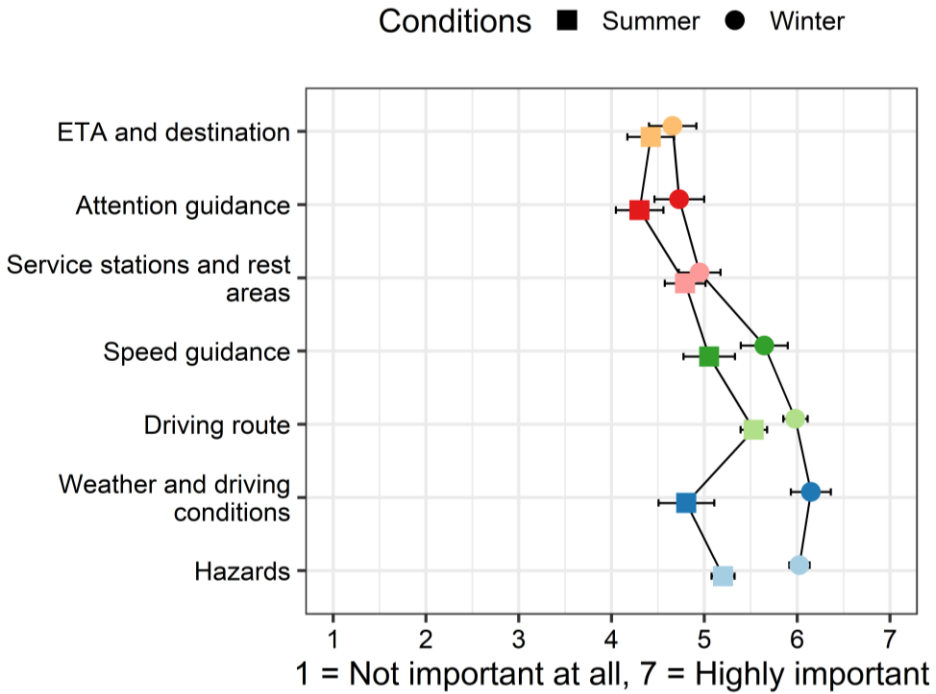
What kind of information is important?

- The importance of different kind of information types was asked
- Summer and winter conditions
- Seven categories were formed
- Weather and driving conditions, hazards, and driving route were the most important types
- Weather and driving conditions, and hazards were more important in winter conditions



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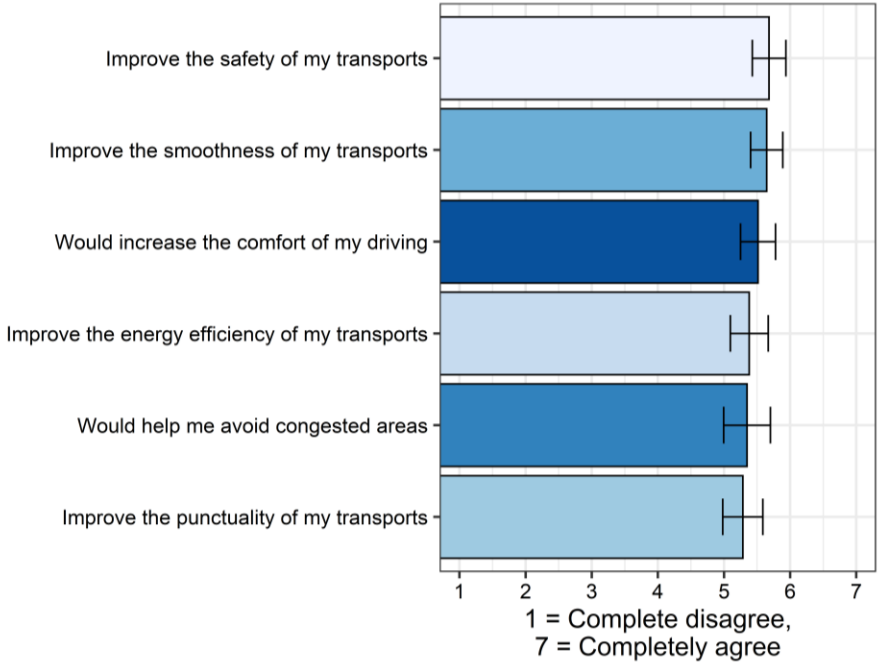
Experienced usefulness of C-ITS services

- Professional drivers experienced the services useful, and they were willing to use them
- Professional drivers were open for sharing information from their route/vehicle to the services
- Some real-time information systems are already in use (speed limits, information about the route, hazard warnings)



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Views from the transport coordinators

- Agreed with the drivers that information on hazards, weather and driving conditions, and driving routes were important
- Real-time information about the route can decrease the delays and detours: improves cost-effectiveness and punctuality
- Transport coordinators did not think that many services are in use by the drivers: no clear overview of the services used

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Views from the service providers

- Most wanted services: Localized and relevant warnings, information about the road surface conditions and slipperiness, weight and height limits on the routes
- Public road infrastructure databases are useful, but the information may be missing or outdated
- Service providers called for open discussion between the public sector and service providers
- Stakeholders are willing to share information if they also benefit from it
- GDPR and data anonymization require resources

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Summary

- To be considered useful C-ITS service must provide relevant extra information
- Some real-time information services are already in use, but the services are not yet based on the C-ITS infrastructure
- The importance of the services are more prominent in winter conditions and in other difficult conditions
- A challenge for the service providers is to offer high-quality and spatially well-covering data in a cost-effective manner
- Public databases are in use, but they are not always up-to-date
- Integration of C-ITS services as a part of route planning and transport coordination should be investigated more

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Thank you for your kind attention

Contact

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EVALUATION RESULTS

Evidence on impacts of road transport automation from a Nordic perspective

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Objectives and methods

- Provide overview of potential impacts of road automation
  - Literature review of scientific publications
- Assess applicability of results in the Nordic context
  - Expert assessment and workshops

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Scope of study

- **Use cases**
  - Passenger cars
  - Public transport
  - Robotaxis, Shared automated vehicles
  - Automated logistics and platooning
- **Impact areas**
  - Vehicle km travelled and modal split
  - Traffic flow
  - Environment (CO_2)
  - Safety
  - Interaction with other road users

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Nordic context

- Winter conditions
- Long distances
- Short motorway networks
- Large share of 2-lane roads
- Low traffic volumes
- High labour costs
- Additionally, global trends such as urbanisation apply

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VKT and modal split

- Automated cars reduce the value of travel time, increasing VKT and the mode share of personal cars
- Robotaxis (shared automated vehicles) may either compete with public transport or supplement it
- Automation can improve the cost effectiveness of public transport and freight transport on roads

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VKT: Vehicle kilometres travelled

Traffic flow

- Mainly studied through simulation
- With optimistic assumptions (low gaps) capacity improves and travel time decreases
- In reality, feasibility of small gaps not clear in the short term
- Research focused on congested situations on motorways

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Environment (CO_2 emissions)

- Total emissions depend on amount of travel (VKT) and emissions per VKT
- Impacts mainly studied through simulation
  - In addition, on-road tests with lower level AVs
- Driving behaviour of AVs can be more efficient in steady-state conditions
  - Contradictory conclusions in disrupted traffic

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Safety

- Main factors: accident risk, exposure, consequences
  - No study found considering all aspects
- Automation reduce accident risk for all use cases, size of effect depend on use case and study environment
- Travel behaviour impacts may influence safety negatively
  - Increase amount of travel i.e. increase people's exposure to accidents
  - Mode shifts from safer modes such as public transport

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Interaction with other road users

- Research has focused on theory building and conceptual work after lots of initial empirical work
- Extensive studies on eHMIs, with mixed results: certain designs have been shown promise, but their role in communication has also been questioned
- What is needed are standards and practices, technical design work, new empirical work

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eHMI: External human-machine interface

Conclusions

- Varied range of assumptions on automation and its capabilities
  - Not always made explicit
- Most research on personal cars and robotaxis, less on impacts of automated public transport or logistics
  - Mostly on motorways and in dense urban areas
- Usually, ideal conditions considered
  - Limited applicability of conditions to Nordic context
- Tradeoffs between safety, traffic flow, emissions
- More research is needed

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